# A modified no-touch technique promotes maturation of autogenous radio-cephalic arteriovenous fistulas: a new surgical approach

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## Abstract

Application of the "no-touch technique" (NTT) in autologous radio-cephalic arteriovenous fistulas (RC-AVFs) may improve the patency rate of RC-AVFs. In this report, we expand the concept of the NTT. We present a modified no-touch technique (MNTT). The MNTT involves preservation of perivenous vascular tissue followed by a functional end-to-side anastomosis to create a RC-AVF that can mature early to allow venous access for hemodialysis.

**Keywords**: Radio-cephalic arteriovenous fistula; Modified no-touch technique (MNTT); Maturation; Functional end-to-side anastomosis

## Introduction

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An autologous arteriovenous fistula (AVF), particularly a radio-cephalic autologous arteriovenous fistula (RC-AVF) in the forearm, is the preferred vascular access for hemodialysis patients. However, one meta-analysis showed that the patency rate of an AVF was only 60% at 1 year after surgery, and 51% at 2 years after surgery[1]. Venous stenosis due to an AVF in the juxta-anastomotic region is one of the main reasons for the low maturation rate[2, 3]. The tissues surrounding the cephalic vein are stripped off in conventional AVF surgery, which can elicit surgical damage to blood vessels, resulting in intimal hyperplasia and venous stenosis. Furthermore, an end-to-side anastomosis is highly recommended and used commonly, which also has a certain role in venous stenosis[4]. A functional end-to-side anastomosis (a side-to-side anastomosis with ligation of distal veins) is a better choice[5].

Souza et al.[6, 7] proposed the “no-touch technique” (NTT) for separation of the great saphenous vein during coronary artery bypass surgery whereby 3~5 mm of the connective tissue around the vein was preserved and did not have direct contact with the vein. Subsequently, Horer et al.[8] were the first to apply the NTT to RC-AVF construction, and achieved very good results.

In this report, we expand the concept of the NTT. We present a modified no-touch technique (MNTT) to create a RC-AVF in which the perivenous vascular tissue remains intact. Compared with the NTT, the purpose of the MNTT is to minimize damage to blood vessels (Fig. 1).

## Surgical procedure

We undertook a comprehensive evaluation of the forearm vessels of the affected limb using color Doppler ultrasound before RC-AVF creation. The MNTT was used to separate the cephalic vein. The surgical procedure had six main steps.

First, a 4-cm skin incision was created where the radial artery was close to the cephalic vein in the forearm. Subcutaneous adipose tissue was isolated with curved hemostatic forceps, and perivenous vascular tissue was preserved intact. If branches of the cephalic vein were present, ligation was undertaken 10-mm away from the main cephalic vein (Fig. 2A).

Second, tissue was dissected layer-by-layer, and the sheath of the radial artery was identified. The radial artery and its companion vein were isolated by a red vessel loop for proximal and distal control. The same method was used with a blue vessel loop to control the cephalic vein. The crossing point of the vessel loop was ≥10 mm away from the edge of the cephalic vein (Fig. 2B).

Third, the artery was opened using a 3.0-mm Beaver knife (Beaver-Visitec International, Sydney, Australia). A 8-mm longitudinal anterior arteriotomy was carried out using Potts scissors. Both vessels were prepared for the anastomosis while preserving the vascular pedicle (Fig. 2C).

Fourth, a vein-to-artery anastomosis (side-to-side) was created with a 7.0 non-absorbable, monofilament, continuous suture using the Kunlin technique. At this stage, although both ends of the cephalic-vein vessels were blocked completely, blood continued to ooze from the inner wall of the vessels. Hence, the vessels were rinsed with heparin saline intermittently (Fig. 2C, D).

Fifth, the distal cephalic vein was ligated to form a functional end-to-side anastomosis (Fig. 2E).

Finally, the surgical incision was sutured with a mattress suture (Fig. 2F).

**Patients and methods**

Between 1 January and 1 February 2021, three patients received modified no-touch surgery to establish a RC-AVF. All patients participated voluntarily and provided written informed consent.

Patient #1 was a 61-year-old man with multiple myeloma who had been undergoing hemodialysis for 10 months. RC-AVF dysfunction was caused by thrombus formation in the proximal vessels of the left forearm. Interventional treatment was not efficacious. Hence, a RC-AVF was re-established on the right arm. Patient #2 was a 79-year-old woman with chronic glomerulonephritis who was not undergoing hemodialysis. A RC-AVF was established for the first time. Patient #3 was a 30-year-old man with chronic glomerulonephritis who had just started hemodialysis, and a RC-AVF was established for the first time.

Physical examination of the three patients 4 weeks after surgery revealed that the cephalic-vein vessels had good elasticity and could be compressed. In the arm-lifting test, the vessels could collapse, with palpable thrill throughout the length, and persistent noises could be heard. Ultrasonographic examination of the RC-AVF at 4 weeks after surgery showed obvious dilation of inner diameter of the radial artery and cephalic vein. The blood-flow spectrum of the cephalic vein 1.5-cm from the anastomosis showed spiral laminar flow (Fig. 3). The blood flow of the cephalic vein 5 cm from the anastomosis was >500 mL/min. The blood flow of the brachial artery was >600 mL/min (Table 1). Two-needle puncture of the RC-AVFs of patient #1 and patient #3 was started in week-3 and week-4, respectively. The blood vessels could be punctured repeatedly, and 4-h hemodialysis was completed with extracorporeal blood flow ≥200 mL/min. Currently, patient #2 does not require hemodialysis, and is exercising to promote AVF maturation.

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## Discussion

We found that the MNTT combined with a functional end-to-side anastomosis could be employed to establish a RC-AVF. The MNTT could lessen the risk of injury to the cephalic vein in the surgical area, and present spiral laminar flow <2 cm from the anastomosis. The RC-AVF matured rapidly, and elicited satisfactory short-term results.

We expanded the concept of the NTT in our patients. Horer et al.[8] were the first to apply the NTT to RC-AVF construction, and garnered very good results. However, only a tissue pedicle of 1–3 mm around the cephalic vein was preserved in their study. We presented a MNTT in which we preserved the perivenous vascular tissue intact. Different from Souza et al.[6, 7] employing coronary artery bypass surgery, RC-AVF establishment did not require venous displacement. Also, we could undertake RC-AVF anastomosis without separating the cephalic vein, which has been demonstrated to be feasible in our practice. During the procedure, the fat and connective tissue around the veins were preserved in their entirety, and injury to the cephalic vein was avoided completely [9, 10].

Marie et al.[11] proposed that spiral laminar flow might be a potential predictor of the maturity of a newly constructed AVF. They also found that spiral laminar flow was present in the non-operated segment of AVFs. In our study, the blood-flow spectrum of the cephalic vein 1.5-cm away from the anastomosis revealed spiral laminar flow in the operated segment of the RC-AVF: we were encouraged by this result. The reason of this phenomenon may be closely related with the MNTT or a functional end-to-side anastomosis. This area merits further study.

Two limitations of our study were the small study cohort and short follow-up time. A randomized controlled study will be needed to confirm that the MNTT is superior to conventional surgery for AVFs.

## Conclusions

The MNTT and functional end-to-side anastomosis for RC-AVF construction were feasible, and the short-term results were encouraging. We suspect that this technique may be more conducive to the early maturity of AVFs, and could be a common surgical procedure in the future.


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## Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Author contributions

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Data collection: Xiaohe WANG, Yuanyuan ZHANG, Jiaying WANG

Writing the article: Xiaohe WANG, Yuanyuan ZHANG

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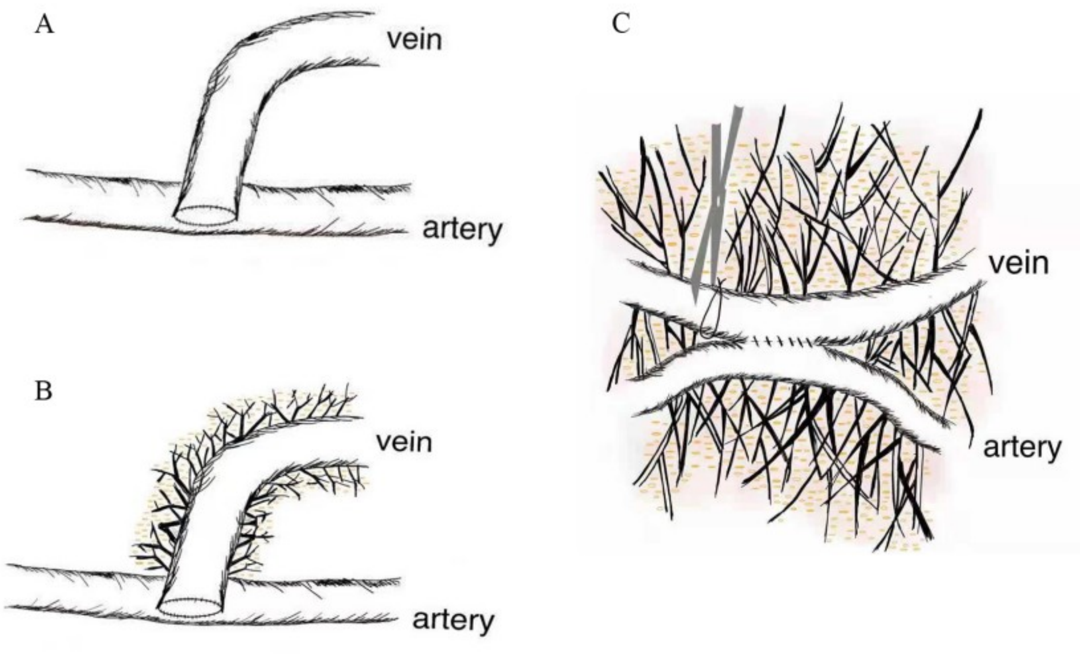


**Fig 1.** A: Conventional surgery for an AVF. B: AVF created using the NTT. C: AVF created using the MNTT and a functional end-to-side anastomosis. AVF: arteriovenous fistula; NTT: no-touch technique; MNTT: modified no-touch technique.

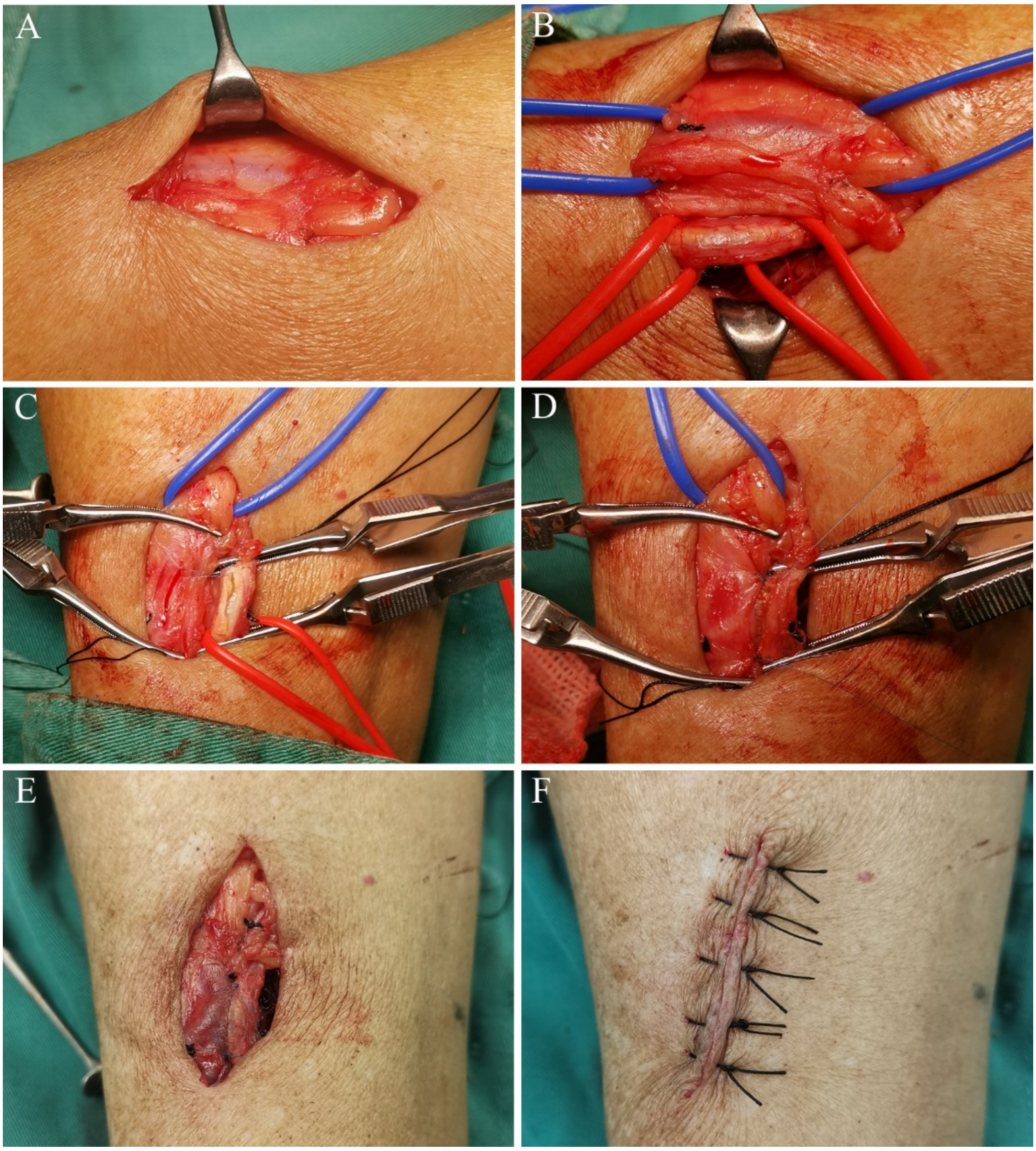


**Fig 2.** An AVF created using the MNTT. A: Exposure of the cephalic vein with the surrounding tissue *in situ*. B: The cephalic vein (blue vessel loop) and radial artery (red vessel loop) dissected using the MNTT. C and D: An anastomosis using the Kunlin technique. E: The distal cephalic vein was ligated to form a functional end-to-side anastomosis. F: The surgical incision was sutured with a mattress suture.

Table 1. Ultrasound results of three patients before and 4 weeks after RC-AVF surgery

| | Preoperative | | 4 weeks after surgery | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Diameter of the radial artery (mm) | Diameter of the cephalic vein (mm) | Cephalic vein 1.5 cm from the anastomosis SLF | Cephalic vein 1.5 cm from the anastomosis Diameter (mm) | Cephalic vein 5 cm from the anastomosis SLF | Cephalic vein 5 cm from the anastomosis Diameter (mm) | Cephalic vein 5 cm from the anastomosis Vessel-wall thickness (mm) | Cephalic vein 5 cm from the anastomosis Subcutaneous depth (mm) | Cephalic vein 5 cm from the anastomosis Flow (mL/min) | Radial artery Diameter (mm) | Brachial artery Diameter (mm) | Brachial artery Flow (mL/min) |
| Case 1 | 2.70 | 2.10 | Yes | 4.13 | Yes | 5.17 | 0.85 | 0.89 | 594.00 | 4.56 | 7.05 | 632.00 |
| Case 2 | 1.71 | 1.84 | Yes | 4.52 | Yes | 4.98 | 0.55 | 4.39 | 586.00 | 2.59 | 3.81 | 735.00 |
| Case 3 | 1.95 | 2.62 | Yes | 4.80 | Yes | 6.60 | 0.79 | 1.40 | 669.16 | 4.01 | 6.70 | 808.00 |

SLF: Spiral laminar flow

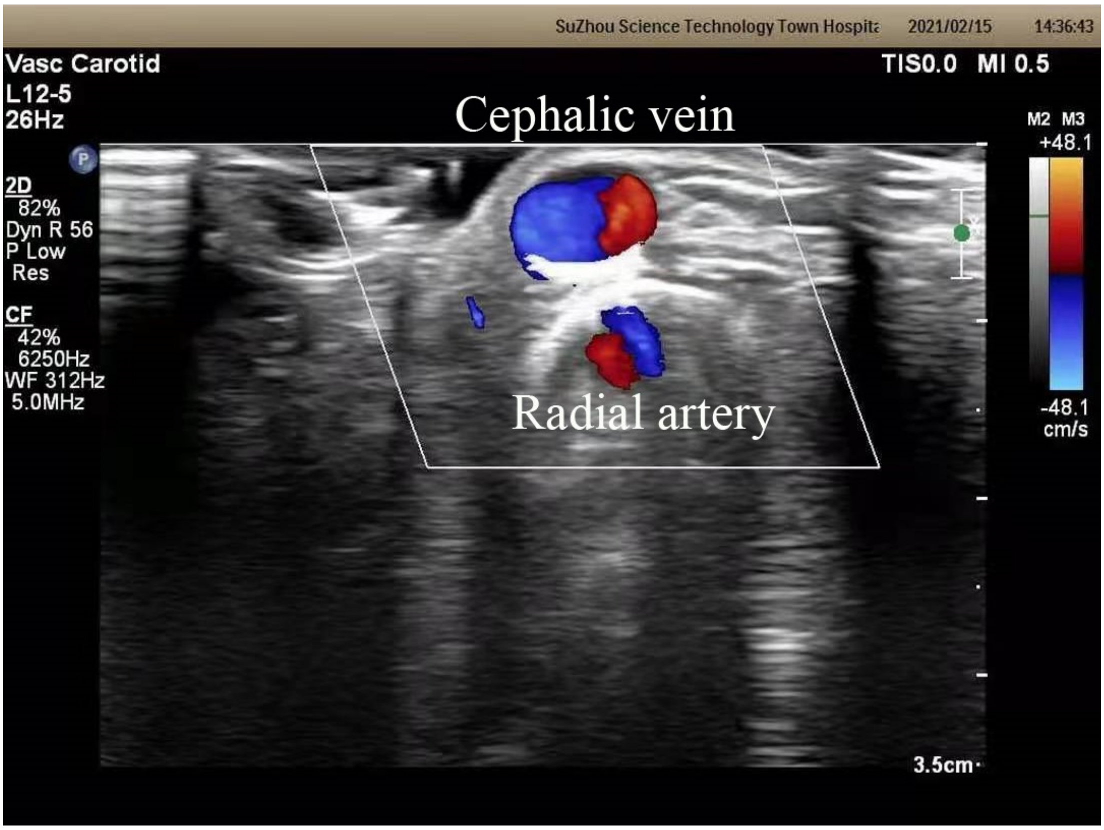


Fig. 3 The cephalic vein and radial artery are shown having spiral laminar flow.



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